

VENTILATION
OF
SCHOOL-HOUSES IN WORCESTER:

REPORT OF
H. M. QUINBY, M.D., AND OTHERS,

AND

EDWARD S. PHILBRICK,

CIVIL ENGINEER,

TO THE SCHOOL COMMITTEE,

NOVEMBER 30, 1888.



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OFFICE OF
SUPERINTENDENT OF PUBLIC SCHOOLS,
492 MAIN STREET.

WORCESTER, MASS., DEC. 8, 1888.

The action of the School Committee during the past year, for securing sanitary conditions in all the school-houses in accordance with present knowledge of the subject, includes the following opinions of experts. They explain themselves; and they are published by the School Committee for the information of the teachers and the public.

The explanatory letter from Dr. Quinby and that from Mr. Philbrick qualify, to a certain extent, the reports to which they respectively relate.

For the School Committee.

A. P. MARBLE, *Secretary*.

AT A MEETING OF THE SCHOOL COMMITTEE OF WORCESTER,
FEB. 7, 1888, IT WAS VOTED—

“That the Superintendent and Committee on School-houses be requested to get the testimony of medical experts, as to whether the systems of ventilation and drainage in our school-buildings are likely to injure the health of pupils, and to report to this Board—provided this inquiry can be made without expense to the city.”

In accordance with the above and on behalf of the sub-committee, your opinion is solicited on the following points; and it is hoped that you will add suggestions.

The average school-room is about 32' x 32' x 10' and it contains from 30 to 50 pupils. This gives an average air space when 40 pupils are present, of 256 cubic feet and of 205 cubic feet when 50 pupils are present. The school sessions are from nine to twelve and from two to four, with recesses in ordinary weather of fifteen minutes at 10:30 and at 3:00, during which the air is generally changed by opening windows. At other times windows are usually opened more or less according to the temperature and the draughts.

1. Suppose such a school-room to be heated by a stove and ventilated by windows when the temperature and the draughts will allow: Is this method of ventilation such that with ordinary use the health of pupils is likely to be injured?

2. Suppose a school-room to be heated by steam pipes by direct radiation and ventilated by windows when the temperature and draughts will allow: Is this method of ventilation such that with ordinary use the health of pupils is likely to be injured?

3. Suppose a school-room to be heated by stove or by direct radiation from steam pipes and to be ventilated by admitting fresh air at the windows when temperature and draughts will allow, and by removing air from the room by an unheated flue of about one square foot in cross section: Is this method of ventilation such that with ordinary use the health of pupils is likely to be injured?

4. Suppose a school-room heated by stove or direct radiation and having small holes near the ceiling aggregating a square foot in area and kept open when the temperature admits,—say nine-tenths of the time, and so distributed that danger from draught is avoided; and suppose the air to be taken out of the room by an unheated flue a square foot in cross section: Is this method of ventilation such that with ordinary use the health of pupils is likely to be injured?

5. If the conditions given in some of the preceding questions are too incompletely stated to justify an answer, will you indicate what further facts are desirable, or if more convenient state what you consider to be the least amount of air that should be removed from the school-room per minute for each pupil, taking into account length of session, air space [205—256 cubic feet per pupil] and the change that usually takes place at recess and after the session?

These questions do not contemplate what is called good ventilation but rather the finding out where the danger point begins or what is the least ventilation compatible with a reasonable care for the health of pupils.

6. Would your answer to the previous questions be the same if pupils were six years old that it would be if they were fourteen? if not, please specify.

7. Suppose water closets to be placed over an iron trough, say 20 feet long and a foot wide and deep, and filled with water to within from six to eight inches below the top of the seat, and suppose this to serve 200 pupils and to be emptied daily in cold weather and twice a day in warm weather: Do you consider the danger from spatter a serious one that requires attention and remedy?

8. Suppose a brick cemented privy vault consisting of two troughs, egg shaped in section, each 20 feet long and three feet wide and deep and filled two feet deep with water, and to be in the basement of a school-house; suppose these to serve 400 pupils and to be emptied daily in warm weather and semi-weekly in cold weather, and suppose the vault to be ventilated by an unheated flue a square foot in section and by windows when weather permits, and the sewer connections, traps, etc., to be effective: Is this system likely to injure the health of pupils?

9. Suppose a privy for 400 pupils placed over a cemented vault, say 25 feet long, six feet wide and five feet deep, and to be 40 feet from a school-building and well ventilated. If this is filled with water two feet deep and emptied weekly, is it likely to injure the health of pupils?

Would it be safer not to use water under such conditions?

If the vault were emptied only once in two months would your answer be the same?

TO THE SUPERINTENDENT OF SCHOOLS AND COMMITTEE ON SCHOOL-
HOUSES, WORCESTER, MASS.

Gentlemen :—The undersigned, having carefully considered the questions proposed in the circular of the School Committee, would reply as follows :

Every pupil should have an air supply of at least twenty cubic feet per minute, to be supplemented by thorough ventilation, through open doors and windows, at recess and after each school session.

All of the methods indicated in questions 1, 2, 3 and 4 of the circular, are totally insufficient for the purpose for which they were intended, and in all, the health of the pupils is, in our opinion, likely to suffer.

In this climate no arrangement of windows or of wall openings can furnish even fair ventilation during the greater part of the school year, as it is impossible to introduce the requisite amount of unwarmed air directly into a school-room without serious danger from drafts.

In regard to question 6, our opinion is as follows: It would be safe, perhaps, in a well ventilated school-house, to give one third less space to pupils six years old than to those fourteen, but in insufficiently ventilated rooms all should have equal air space.

The danger from spatter of fecal matter in the water closets described in question 7 cannot be a serious one, with proper attention on the part of the Janitor. To better insure this attention, it would be advisable to remove all wood work from the front of the latrine, and to so arrange the seat that it can be turned back exposing the trough in all its parts.

The privy vault referred to in question 8 is a very dangerous adjunct to a school-house, and however carefully it may be looked after, is likely, sooner or later, to prove a source of infection.

The vault described in question 9 is an arrangement not to be tolerated under any consideration whatever.

H. M. QUINBY.
CHAS. A. PEABODY.
L. F. WOODWARD.
JOHN G. PARK.
THOMAS H. GAGE.

Worcester, Mass., May 9, 1888.

The opinions above expressed are based upon the following considerations, and embody the latest views of modern sanitarians respecting the points in question :—

Ventilation implies a constant supply of fresh air sufficient for the prompt removal, or the proper dilution of any impurities likely to occur in the air we breathe. The amount of air necessary to effect this object varies with the amount and kind of impurities present. In our dwellings, the chief source of contamination comes from the processes of respiration and combustion, although if our homes be faulty in construction or neglected, other and still greater impurities may be present as the result of the disintegration and decay which is constantly going on in all organized substances. These latter impurities however can readily be guarded against by cleanliness and by the prompt disposal of all effete matter before the process of decay sets in. The question, therefore, which is here presented for solution is one of prevention rather than of removal and belongs to another branch of sanitary science, leaving to ventilation its proper office of protecting us from those constant and unavoidable impurities which result from respiration and bodily exhalations.

Expired air is composed chiefly of watery vapor, carbonic acid (CO_2) and organic matter.

Many regard the carbonic acid as the noxious principle in this compound, but from the fact that atmospheric air with even two per cent. of CO_2 added can be breathed without discomfort or injury, it is evident that carbonic acid, unless present in greater quantities than is usually found even in the worst ventilated apartments, is not injurious to health. It is probable, therefore, that the poisonous agent in expired air must be sought for in the organic matter given off at a high temperature and saturated with moisture—the essentials for rapid decay.

The late investigations of Brown-Sequard and d'Aarsonval go to confirm this theory. They find that the lungs of man, the dog and rabbit, produce, normally, an extremely active poison which is eliminated continually with the expired air. According to those writers, this substance is apparently an alkaloid, and is probably the principle which renders confined air dangerous.

Absolutely pure air is, undoubtedly, essential for the most complete physical development, but it is nevertheless probable that our systems may become tolerant of a certain amount of impurity, and in this, as in other cases, receive no appreciable injury therefrom, provided the dose be not too great or too often repeated, and especially if it be supplemented by a considerable daily exposure to the outside air.

¶The question arises therefore, as to where the danger line begins. Upon this point, the rule laid down by Dr. Parkes in his *Manual of Practical Hygiene*, is the most simple and easily applied. He says, "That, without attempting too much, it may be fairly assumed that the quantity of air supplied to every inhabited room should be great enough to remove all sensible impurity, so that a person coming directly from the external air should perceive no trace of odor or difference between the room and the outside air in point of freshness."

Although the above rule is of great practical utility in determining whether a room is well—or ill—ventilated, it furnishes us no means of measuring the exact amount of impurity present, or of estimating the quantity of air necessary to produce the required degree of freshness.

When we attempt to subject the air of a room to chemical analysis, we find that the processes necessary for estimating the organic matter are long and complicated, and that they seldom insure exact or satisfactory results. The carbonic acid, on the other hand, is easily determined, and although it contributes but little towards vitiating the air we breathe, it bears a constant relation to the organic matter present, and may therefore serve in estimating the more important impurity. Taking the CO_2 as a measure, we find that the organic matter begins to be perceptible to our senses when the carbonic acid of respiration reaches two parts in ten thousand. When one per cent. of CO_2 is present, the air becomes exceedingly offensive.

The quantity of carbonic acid which a person exhales, varies with his age, weight and condition. According to Dr. Parkes's estimate, an adult male in a state of repose, weighing—say 160 lbs.—gives off 0.7 cubic feet of CO_2 per hour; an adult female (120 lbs.) 0.6 cubic feet; children (80 lbs.) 0.4 cubic feet; amounts which may be largely increased, and even doubled, during active exertion.

If an adult male exhales 0.7 cubic feet of carbonic acid per hour, he should have, according to the above standard, an hourly supply of 3500 cubic feet of fresh air to replace that vitiated by respiration, and if children exhale 0.4 cubic feet per hour, the supply of air necessary for them would be 2000 cubic feet.

Some authorities hold that these estimates apply only to apartments which are occupied continuously, and that in school-rooms, on account of the shortness of the session and the opportunity for frequent ventilation through open windows, this amount may be considerably reduced without endangering the health of the pupils. None of these authorities, however, think it safe to reduce the amount of fresh air below 20 cubic feet per minute.

Since your circular explicitly states that these questions "do not contemplate what is called good ventilation, but rather the finding out when the danger point begins or what is the least ventilation compatible with reasonable care for the health of the pupils," it may be well to say, just here, that we do not regard 20 cubic feet of air as providing anything more than tolerable ventilation. There would still be a very sensible amount of impurity in the school-rooms, and the same care that is now used in assisting ventilation by open windows, would still be necessary. Although this amount of air is probably as much as it is possible to provide in old school-houses without too great expense for alterations, it is, in our opinion, much less than is desirable. In all new buildings, provision should be made for a supply of from 25 to 30 cubic feet per minute for each scholar.

Applying the above conclusions to the school-rooms in question, we find that a room 32' x 32' x 10', containing an average of 40 pupils would require 48,000 cubic feet of air per hour; that is, that the entire air of the room should be changed every fifteen minutes.

At a temperature of 60° and under, air cannot be admitted at a greater velocity than two feet per second without creating unpleasant drafts. At this rate and temperature it would require seven square feet of clear opening to supply the required amount of air for the above room, or eight of our common 12" x 18" valve registers.

From this, we conclude that all of the methods of ventilation indicated in the circular are alike faulty and that they differ only in degree. Just how faulty the ventilation is in each case, it is difficult to decide from the data at our disposal; but it is a question whether one fourth of the amount of air necessary for even fair ventilation is secured when all the available inlets are kept open to the fullest extent that temperature and drafts allow.

It may not be possible to prove in every case that the health of the pupils is injured by such a system, but the fact holds, nevertheless, that there is always great danger from breathing air vitiated by the products of respiration. This danger varies according to the amount of impurities present and the length of exposure. When the exposure is only for a short period, headache, dulness and slight febrile action may alone result. The cause being removed, these symptoms pass off with greater or less rapidity according to the recuperative powers of the person affected. But when the exposure is frequently repeated, these symptoms become more persistent, and even if no actual disease results therefrom, the whole tone of the scholar's system may be so

lowered as to interfere seriously with his physical development, and to render him less capable of throwing off any disease to which he may hereafter be exposed.

It is amply proved by observations upon soldiers in crowded barracks, prisoners in jails, and animals in close and unventilated stables, that when a considerable number of persons are confined for a length of time in close and unventilated apartments, they soon lose color and strength, and become readily susceptible to acute and chronic lung diseases.

The poison resulting from the act of respiration, unlike that of diphtheria and typhoid, acts slowly and presents at the outset no alarming symptoms, nor such as are likely to attract the attention of the casual and untrained observer. In many cases, nevertheless, it is undoubtedly the chief factor in laying the foundation of future lung disease, and especially of consumption.

In regard to question 6, there seems to be a certain diversity of opinion among sanitary writers. De Chaumont, basing his opinion upon the difference in the amount of carbonic acid given off by children of six and youths of fifteen years, would place three times as many of the former in a given space as of the latter.

Dr. Parkes thinks that children, on account of a more rapid tissue change, exhale more CO_2 in proportion to their weight, than do adults. Dr. Billings would give the same amount of air to all classes. Dr. Lincoln holds that the estimate based upon the difference in the amounts of carbonic acid expired by primary and high-school pupils "is admissible only on the supposition that the ventilation is efficient. In case of defect, or apprehended defect, young children should have equal room with older ones, on the ground of their comparative inability to cope with the deleterious effects of bad air."

There are many objections to a vault like that described in question 8.

FIRST. It is badly located, being in the basement, and directly under the school-rooms, with no adequate means of preventing the corridors and rooms above from acting as its ventilator.

SECOND. It is practically unventilated, since an unheated flue is as likely to give a downward as an upward draft.

THIRD. It is unnecessarily large, and is difficult to properly clean. In fact, it cannot be cleansed so thoroughly that it may not prove a source of infection under certain circumstances.

The privy described in question 9 should be abolished at once. The process of cleaning is so difficult and disagreeable that such closets are

invariably neglected, and soon become both disgusting and dangerous.

Where water carriage is impossible, as in the country, or out-lying districts of the city, a vault of some kind is necessary; but in place of a huge receptacle intended to hold a year's deposit, the closet should be so arranged that the fecal matter can readily be disinfected with dry dirt or fine ashes, after each school session, and can be easily removed.

WORCESTER, MASS., May 29th, 1888.

Dr. A. P. MARBLE,

Supt. of Schools, Worcester, Mass.

Dear Sir:—In response to your note: I certainly misunderstood question 9 of the school committee's circular and I have no doubt all of the gentlemen who signed the reply did the same. In the question as stated, there is nothing to indicate that the vault has a sewer connection. We took it for granted, therefore, that a common cesspool was intended,—to be cleaned out in the usual way.

A vault with a sewer connection can of course be cleaned daily and even more frequently, if necessary, and, therefore, hardly deserves so sweeping a condemnation, perhaps, as that given it in the reply to your committee's circular, still, to my mind, any arrangement like the one in question is very undesirable and should be abandoned as soon as practicable. Such a closet is difficult to keep clean. There is a constant temptation to allow its contents to accumulate unduly, and it will most certainly be neglected unless it is subject to frequent and careful inspection.

The above, however, are not the only objections to this system. The danger from exposure is often a serious one in cold weather, where outbuildings are placed at a considerable distance from a school-house and are unheated, but a still greater danger comes from the neglect of the calls of nature which such a system necessarily encourages. Regular habits in these matters are quite as essential to the health and well-being of the child as good drainage and pure air, and, everything that tends to encourage the putting off or ignoring of this most important function should be avoided.

Although unwilling to commend the above system, even with water-carriage added, I am of the opinion that the vault in question, if carefully looked after, can be made reasonably safe as far as danger from infection goes. It will require constant attention, however, and a great

deal of work to keep it in this condition. It should be emptied—not “once a month” or “once a week”—but sufficiently often to prevent it from becoming in the least offensive, and when emptied it should be thoroughly scrubbed in all its parts with soap-suds, followed by disinfectants. The trouble is that vaults, like all utensils used for a similar purpose, are not cleaned when simply emptied; this the average janitor fails to understand and, however good his intentions may be, he seldom does his work thoroughly.

Yours respectfully,

H. M. QUINBY.

WORCESTER, MASS., 27 Nov., 1888.

MR. EDWD. S. PHILBRICK, C. E.

Dear Sir:—Please examine the condition of the plumbing and drainage of the school-houses named below, and report to me for use of the school committee :

1st. Whether there is anything in either the plumbing or the sewerage which is injurious to the health of the pupils.

2d. What is your opinion of the ventilation of the school-rooms.

3d. If any improvements are necessary, please indicate what they should be.

Houses.—Belmont Street, Gage Street, East Worcester, Millbury Street, Lamartine Street, Woodland Street, Freeland Street. Thomas Street.

Yours truly,

A. P. MARBLE, Supt. of Schools;
for Com. on School-houses.

OFFICE OF EDWARD S. PHILBRICK, CIVIL ENGINEER,

12 West Street,

Boston, Dec. 1st, 1888.

MR. A. P. MARBLE, Supt. of Schools,

Worcester, Mass.

Dear Sir:—I enclose herewith my report upon your school houses which is, I fear, longer than it need be. Yet I did not see how to condense it without a risk of being misunderstood. I took the liberty of giving such general rules as may be applicable to other buildings, which I did not see, and which you can so apply at your discretion, or to any new buildings which you may have in view.

If it should seem to you that in criticising methods which we cannot prove to be *unsafe*, I have not confined myself strictly to the subject of the health of the pupils, it must be remembered that we are yet far from knowing all about the *etiology* of many common forms of disease, and that no precautions are unreasonable which do not involve a large cost and which yet have an undoubted salutary effect upon the pupils, *morally*, besides a possible and probable effect in combating disease among children in its embryonic condition, where it is still quite obscure.

It cannot be expected that my standard requirements as to methods of construction should be applied to all the old buildings. They are probably not worth the outlay that would be required in many cases. But I wish to urge, without reserve, such a standard of cleanliness in daily administration as I have indicated, among the children of the poorer classes. It is, undoubtedly, more difficult there than elsewhere, but the lesson to be taught by such an example is all the more valuable in proportion to its rarity or novelty among the children themselves. Such standards, and even higher ones are now enforced, amid even greater difficulties, in various public institutions where the consequences of neglect are felt to be of great importance to the health of the inmates, viz., in our hospitals, asylums and infirmaries. It is hoped that the pupils of our schools are less sensitive to infection from such sources than the inmates of hospitals. Yet this is not known beyond a doubt; while we *do* know that a high standard of purity is of more consequence as an example and a moral stimulus to the pupil of the public schools than to the adult in the hospital, whose character has become more mature.

This reason should, in my opinion, be kept constantly in view by those in charge of the pupils' welfare and education.

Very truly yours,

EDW. S. PHILBRICK.

BOSTON, Nov. 30, 1888.

MR. A. P. MARELE, SUPT. SCHOOLS, WORCESTER, MASS.

Dear Sir:—According to your request, I inspected five of your school-houses on the 28th inst., with such degree of thoroughness as the time permitted. This sufficed to get a good idea of the nature and quality of all the sanitary fixtures and their surroundings, together

with the appliances for ventilation and heating. But it did not suffice to test the drains and soil pipes for tightness of joints. This test can be made by any good local mechanic if considered desirable; but I could detect no leakage by the sense of smell, nor did I hear of any such symptoms.

The waste pipes from all sinks are well provided with traps that cannot be emptied by siphonage, and in most cases the soil pipes extend visibly to the open air above the roof. The ventilation of the sink wastes is not so general, but I do not regard this as a matter of much importance as affecting the health of the pupils, though such ventilation tends to guard against corrosion of the pipes and is therefore recommended in all new work, as a measure of economy, whatever kind of traps are used.

I found the sanitary fixtures generally in good working order, with some exceptions noted below, and saw nothing which is likely to be immediately injurious to the health of the pupils, though the conditions in some cases should be improved before the frosty weather prevents the frequent opening of windows.

In this connection, however, I should state that the conditions affecting the air breathed by children when confined for some hours in rooms artificially heated, can hardly be guarded with too great jealousy and care, and that certain conditions now here existing though not positively dangerous or sure to produce illness among persons of ordinary health, are yet considerably below what I believe to be a proper and reasonable standard as to purity.

Modern researches in regard to the causes promoting contagious diseases tend to show that it is next to impossible to exclude all such agents from the air we breathe, so long as we continue to circulate among other people and pursue the ordinary avocations of life. Complete isolation from poisonous or morbid influences is so far impracticable as to become inconsistent with our daily duties and therefore cannot be sought for with propriety. All we can be expected to do is to exert a reasonable degree of caution in the control of our surroundings, consistent with what we find to be our duties and within a reasonable expenditure of means. There are many details concerning the construction of the sanitary apparatus in such of your schools as I have visited and more especially as to the daily management of your buildings, in which it seems to me some changes for the better are demanded within the limits above indicated, many of which are of quite general application, and others more local, which will be specified below.

I would make the following general recommendations. Those which apply to forms of construction are given as a standard or model to be held in view and worked up to whenever erecting new buildings or making such changes in the old ones as a true regard for economy and the welfare of the pupils may dictate. The advice as to the administration can be applied at once, so far as you appreciate its value and importance.

FIRST.—THE BEST METHODS OF CONSTRUCTION AND ARRANGEMENT OF FIXTURES.

Plumbing fixtures should in all cases be arranged as compactly as possible. Those which are provided for the convenience of teachers should always be directly over one another on the separate floors, so as to be served by vertical lines of pipes for drainage and water supply. Such fixtures should be placed near, but not against the exterior wall of the building, so as to be lighted and aired by a near window in this wall, but not subjected to the exposure to frost incident to being placed against the exterior wall, except on the south side of a building. The water closets should in all cases have their traps above the floor, and have their water supplied from a small separate tank over each closet. The common "short hopper" patterns are the best for such places, and lead traps are preferable to iron ones, because smoother and cleaner. A separate trap should be provided for each closet, sink, or bowl, and each trap should have an air pipe from near its top, of same size as the wastes for all traps except those serving water closets, which should not be less than two inches in diameter. These air pipes should all be branched into a vertical pipe of 3" diameter alongside the soil pipe by Y branches, and so arranged as to drain freely, and this vertical air pipe may be branched into the soil pipe by a Y, located above the highest receptacle for drainage and extended through the roof to such a height as will guard against its obstruction by snow. The part passing through the roof should never be less than four inches diameter and should always be left wide open, without bend or cowl of any kind. But if the roof be flat and accessible to children, the end of the pipe may be covered by a wire basket to prevent them from putting stones, etc. into it. If using cast iron soil pipe, it should always be of the double thickness, and should be tested for tightness by plugging the outlets and branches and filling with water to the top before applying any fixtures to it. A better class of pipe for public buildings is now made of wrought iron with screw joints, and coated with the

Bower-Barff process to prevent rusting, by the Durham House Drainage Co., of Boston.

The water closets and urinals for the school children should be located in a one-story wing or projection from the basement story of the building, in order to provide the necessary amount of light and air to ensure cleanliness. The best pavement is that of Portland cement mortar, which need not be over half an inch in thickness, if spread upon a substratum of concrete three or four inches thick, composed of American hydraulic cement and gravel, as usually prepared for cellars. The Portland cement may be mixed with three times its bulk of sand, but the latter should be either the best beach sand or well washed to remove dust and clay if from pits or natural deposits. This item of washing the sand will often make all the difference between a durable surface, good for twenty years service, and a crumbling one, never satisfactory from the first. This skimming of Portland cement mortar should be applied while the foundation is damp and should be kept damp by sprinkling and exclusion of air drafts for a week after application. Rapid drying by a free circulation of air renders it soft and crumbling, while, if kept wet, it will be as hard as stone in a few weeks.

For water closets in primary schools the best trough sinks, if properly attended, are probably the safest form of apparatus. The simplest form of seat is the best, but these should be easily removable for cleansing. Boys' urinals should not be provided with crockery bowls, but are better if made of plain upright slate or soapstone, with a trough at the base of the same material and a sprinkling tube from 3 to $3\frac{1}{2}$ feet above the floor, so constructed as to wet the *whole surface* of the slate below the tube when the water is let on. For children over twelve years of age separate water closets may be desired, but I consider the trough a better piece of apparatus for all classes, if carefully looked after by the attendants. If separate closets are ever used, I should avoid all iron as a material in their construction, and use short crockery hoppers with lead traps above the floor. The supply of water should be drawn in this case by a $1\frac{1}{4}$ -inch pipe and 2-inch valve for each closet, from a tank directly above, which can extend the whole length of the range of closets and be fed by an automatic ball cock. Children can never be depended upon to discharge the separate closets and this has led to various mechanical devices for automatic flushing by wires or chains attached to the doors or seats. In theory these are very good things, but I have never yet seen such devices that could be depended on for many weeks at a time. When they fail, they at once create a wretched nui-

sance, as is now to be seen in some of your schools described below. It is for these reasons that I recommend the trough system for all classes, with thorough and systematic attendance, which is the only way to secure proper flushing in public schools that I have yet seen, and cannot be considered as an unreasonable tax upon the attendants.

A system of hoods and air-pipes leading from the water closets and urinals to some aspirating flue for removing the effluvia, has been generally applied in such of your school buildings as I have seen, and with various success. In order to make this system of any real value the aspirating flue should be kept well heated, at all seasons of the year, by a special stove. I find such an arrangement in some of your buildings, *e. g.*, the Belmont-St. School. When depending on steam pipes or furnace smoke-flues to supply the necessary heat for the aspirating flues, the whole system is sure to fail when most needed, *viz.*, in moderate or warm weather, when there is no wind to remove the effluvia through open windows and when putrefaction is most rapid and the health of pupils more likely to be injured, owing to the general climatic conditions at such seasons. Ordinary summer diarrhœa is then often epidemic, and dysentery becomes contagious. The application of these hoods and air pipes leading to flues that are not heated except in winter and even then perhaps insufficiently, as I find in many of your buildings, is, in my opinion, likely to produce more harm than good, for it leads to a sense of security where it does not exist in reality, and may thus take the place of a proper attention to the cleanliness of the floors and walls, troughs, etc., on the part of the attendants.

The apparatus for the ventilation of the school-rooms themselves next claims our attention. Since the heat supplied for comfort in winter is generally used in our climate as a motive power to secure a change of air in the rooms, the subject of ventilation is inseparably connected with that of heating. This agent may be made sufficient, and produce satisfactory results in buildings having but ten or twelve rooms or less, but larger ones may with advantage use fans or blowers to move the air by mechanical force. Since other reasons exist apparently for limiting the size of your school buildings to those containing ten rooms or less, the consideration of applying such mechanical apparatus will not now be considered. The heat of the air becomes a motive power by reason of the force of gravity. Hot air is lighter than cold air and floats by its own buoyancy, while the cooler air displaces the lighter by its superior weight. It is generally accepted by physiologists that fresh air should be supplied in school-rooms when occupied at the rate of at least 40 cubic feet per minute for each occupant.

Where a smaller allowance is provided, the pupil suffers a degree of loss of vigor, indicated by sleepiness and stupor, and generally impaired vitality. The system of heating by stoves or by direct steam, provides no means for introducing fresh air, and is therefore not to be recommended except for halls or passages, or for supplementing in exposed places during severe weather the better system of heating by indirect steam or furnaces. Furnaces serve a good purpose for small buildings, but are not well adapted for larger ones, owing to the difficulty of distributing hot air horizontally, while steam can be supplied from a single fire and distributed for considerable distances

By the indirect system, so called, the steam is deployed in coils of pipe in the basement underneath the rooms to be heated, these coils are encased by sheet iron chambers to which air should be conducted by close conduits from the northern and western sides of the building through holes in the basement wall. After being heated by the steam coils the air rises in other conduits to the rooms where heat is needed. As the steam is always as hot as 212° Fahrenheit and hotter as the pressure is increased in the boiler, a room could be heated to the desired temperature, say 65° , by introducing a small quantity of air heated to 200° , or better by a larger quantity at a lower temperature. The volume of air introduced is regulated by the size of the ducts and these should be so proportioned as to supply the air in quantity sufficient to meet the requirement above indicated, according to the number of pupils to be provided for.

The volume of air in motion should be the same, as near as may be, for all conditions of the weather, and the temperature regulated by the amount of steam admitted to the coils and the temperature of the same, which varies with the boiler pressure, and is therefore, within certain limits, under the control of the fireman. In order to avoid disagreeable drafts within the rooms, it is found best to introduce the heated air at a point above the heads of the inmates, say 8 feet above the floor. Its buoyancy carries it directly to the ceiling, wherever the inlet may be, and it spreads around the ceiling and descends along the coldest sides of the room. In order to ensure a complete circulation and the continual and successive displacement of all the air in the room, it is best to withdraw the vitiated air from near the floor and on the same side of the room at which the hot air enters. The ducts for removing it should be rather larger than those admitting the fresh warm air, in order to avoid drafts near the point of exit, and the upward movement of spent air in the ducts by which it is withdrawn must be helped by artificial means. The method easiest of application for this result is to

apply one or more steam pipes within this flue, into which hot steam is admitted, and by which the flue may be heated to a degree considerably above the temperature of the room, to add buoyancy to the air as it escapes. It will readily be seen that if the openings for the withdrawal of the spent air are made near the ceiling, the fresh air will escape by passing directly from the inlets to the outlets without the entire change of all the air of the room which we seek. Openings for outlets near the ceiling are therefore mischievous in cold weather. They are found upon one floor of your Millbury-St. School. They may be of use in summer weather, but are hardly worth providing at this season if the windows extend to a point near the ceiling as they always should do, and if made to be opened from the top downward.

Thermometers should be supplied in every school-room, and the person in charge of the fires should consult them frequently, and be governed by their indications.

65 to 68° Fahrenheit is a proper temperature for school-rooms in winter. Particular pains should be taken in proportioning the size of the air ducts, to accomplish the desired movement of air without creating drafts in the room. For this end the ducts should be made of sufficient size to do their work without a more rapid movement at the openings than 6 feet per second. Even a less rate is desirable.

SECOND.—THE PROPER SANITARY CARE OF SCHOOL-HOUSES.

Although a good deal of attention has been directed to this subject and a marked improvement made within a few years, much remains to be done; in my opinion, to attain a proper and reasonable standard of purity in all our large cities. Cleanliness is not only of importance in its effect upon the health of the pupils, but as an agent for elevating and civilizing in its influence upon their character. Much more can be taught by example in this respect than by precept. Although the standard now generally maintained in your city, so far as I have opportunity to judge of it, may be above that to which the pupils are accustomed in their own homes in many cases, it is still susceptible of great improvement within the limits of what I consider reasonable and proper.

Modern appliances have brought conveniences under the roofs of our buildings which former generations consigned to out-buildings, and this has been justified by the use of sewers and a copious water-supply by means of which all filth can be at once removed from the premises. Such is the theory of the modern water-closet. In practice, however, it is not always remembered that all the filth should be actually put into

the running water. Laxity of discipline exists to a very large extent in this respect in your school-houses, due probably to ignorance on the part of the janitors of the importance of a high standard of cleanliness, aggravated by a certain amount of inertia and a tendency to follow old ruts and in some cases also by defective apparatus, of which instances will be pointed out below. Possibly also the force at present employed is not sufficient for the purpose, but I am not in a position to judge of this as well as yourself.

I have spoken above of the need of good light in and around all places of easement. Where a badly lighted cellar is used, the janitor readily falls into careless habits. In order to remedy this defect as far as possible at a small cost, all the stone and brick walls of the basements should be whitewashed with lime as often as twice a year, and sometimes oftener, where necessary to keep the surfaces bright and pure. The wooden partitions should also be painted a light color, lemon or straw color is preferable, so that soiled places can be readily detected and cleaned and the greatest possible amount of light reflected upon all dark corners. The floors at present are generally of rough concrete or rougher brick (as at the Woodland-street school). The rough and crumbling surface is not adapted to promote cleanliness, and dark color aggravates the trouble.

Portland cement surfaces, as above described, are far preferable on account of the light color of the material. The concrete now heretofore used was apparently made with poor materials and crumbles readily, becoming absorbent of filth and difficult to clean. There is but little use in trying to have such floors constructed by contract. The facilities for cheating in providing inferior materials and workmanship are too great to enable any reasonable amount of inspection to guarantee first class work by contract from the class of men usually dealt with. Poor work in such places is a waste of money. Such floors should be laid by day labor, using intelligent supervision, which can be had probably in your case by applying for help from the department of sewers and the city engineer.

All the floors about the water-closets, etc., should be washed by scrubbing brushes daily and rinsed several times daily in hot weather by using the hose, and all woodwork should be carefully washed daily with warm suds where coming in contact with the person or subject to spattering of any kind. In order to avoid too much dampness in the air, while the pupils are about, these washings should be performed immediately after school hours, and the proper degree of heat maintained in cold weather to dry the surfaces as soon as possible. The

use of Carbolie soap is often necessary around urinals, especially when younger boys are accommodated. I found this used with advantage at the Belmont-street school, and it could be so used where it is not, at the Millbury-street school annex.

The use of the ventilating apparatus is often a subject of great mystery to the teachers as well as the attendants. I found the outlet valves closed in some rooms, apparently from ignorance or inadvertence, and the air consequently very oppressive, while a good draft seemed to exist, able to improve the condition of things materially soon after opening them. I think the use of these fixtures should be explained to all teachers, and they should not be allowed to close them without good reason. If any local reason exists for their disuse, it probably arises from fault of construction which should be remedied. No amount of skill will give us ventilating apparatus that will be at all times successful automatically. If not looked after by persons who understand its uses and abuses, the desired object is seldom attained, except by accident. The flushing of school-rooms with fresh air by opening windows during recess time and after each session is generally rendered necessary by the imperfection of other means of renewal of air, and it is perhaps better understood than the management of any other apparatus. Unfortunately we have a good deal of weather in winter where this is inconvenient. It may be difficult and perhaps unreasonable to expect the enforcement of such a standard of cleanliness about water closets in public schools as I have in view while working through the class of men now generally employed as janitors. But I think these men would do excellent work in most cases if clearly informed what is expected of them in detail and if supplied with the necessary assistance to do the actual labor required. This last cannot be a severe tax upon the treasury and will be appreciated by the pupils in after life as much, I think, as any part of their instruction received at school. I mean the example of purity which should be constantly before them in these places. The desired result can never be attained till the janitors are not only carefully instructed in *detail*, but industriously *followed up* with military precision and fear of dismissal in case of neglect of duty. Some one must do this duty of inspection who has a real interest in the subject and who will take an honest pride in the result gained, but one person can cover a large number of schools, if inspecting them without notice and if vigilant in his discipline. The janitor's employment should be under his control to make his work efficient.

I will now describe in detail the special defects met with at the va-

rious buildings visited, some of which can be easily remedied, while others may require an outlay of money to cure them which would be unwise to incur in the present buildings, for economical reasons, *i. e.*, the building may not be worthy of such outlay,—of which question you can judge better than myself.

Belmont-St. School.—Heated by direct steam. Therefore no provision exists for admitting fresh air at a proper temperature in winter. Many of the rooms have no outlet for vitiated air. Those outlets which are so provided in some rooms are of little use, because no fresh air is admitted except by leakage through cracks, &c. Air can't be expected to pass out of a room freely unless freely admitted.

Teachers' water-closets are of a poor pattern, difficult to keep clean and therefore unclean; with too long crockery bowls and a filthy surface of needless length above the water.

Basement floor rough and dark, dingy—walls need whitewashing. Woodwork about closets looks dirty and dark. Floor about urinals well rinsed and sweet, in good order considering its roughness.

Special stove in ventilation flue—a good thing—giving exceptionally good service in changing the air about the fixtures, including the whole apartment.

The trough latrines are of a good material—iron. If these trough latrines are emptied and fresh water supplied four times a day, I should consider it an ample service except when contagious diseases are prevalent.

Gage-St. School. Rooms heated by direct steam, therefore lacking a proper supply of fresh air. Outlets for bad air seem to have a tolerable draft however, supplied by leakage through window cracks and windows partially opened at the top. Such a circulation would not be practicable in frosty weather, though pretty good this week. (Thermometer outside, 55°.)

Indirect steam heat in halls, supply of air taken from ceiling of basement and not from the outer air, so far as I could discover. As the air in basement is foul for reasons given below, this is a particularly bad feature. Easily corrected however by supplying air ducts from outside the walls and removing sources of impure air inside.

Basement floor rather rough and walls need whitewashing. Woodwork dark and dingy. Girls' water-closets have separate bowls with dirty iron bases supplied (theoretically) by an automatic apparatus connected with the doors. This is out of repair and apparently of such cheap and poor construction that such is its normal state; so that out

of 10 closets, only four are supplied with a good flush of water. Fecal matter piled up in the bowls in some cases and foul air abundant.

On the boys' side there is a good trough sink that would do good service if the surroundings were cleaned oftener. Urinals have crockery bowls, apparently too high for use; at any rate there is considerable urine about on the floor, which is not constructed to take it and has no adequate washing; strong effluvia from decomposition of urine.

I consider the porcelain urinal a complication worse than useless. They should be replaced by plain slate or soapstone slabs, with sprinkling tube as explained above, see p. 15.

There is the usual provision for removal of foul air by hoods and pipes leading to hot flues, but all this is inadequate to the purpose and the effluvia are carried up through the steam coils to the halls as above noted.

The sink waste-pipes do not, as far as I can see, extend to the roof, but I do not consider this a vital point, as above explained, so long as good traps exist, *as they do in this case.*

East Worcester School.—Heated by stoves. The one in evening school-room discharges carbonic oxide gas into the room, which is poisonous, and this should be remedied at once. This kind of heating apparatus does not admit of any adequate ventilation in winter and none exists.

The sanitary arrangements in the cellar are good, but whitewash and soapsuds are needed as in other places noted above.

Lamartine-St. School.—Found the building locked and the janitor absent (2.30 P. M.) By looking through a window I saw one school-room is heated by stove. As this method is fully alluded to above, I need not repeat the comments made in that connection.

Sanitary conveniences in a separate building in the yard, consisting of a dirty set of seats (unwashed) over a vault which holds a certain amount of filth, continually putrefying and poisoning the surrounding air. Such a thing cannot fail to be a public nuisance. Though said to be connected with the public sewer it is not a cleanly or proper arrangement. If supplied with heating apparatus to exclude frost, a trough sink water-closet could be applied here as in other places with success, but the nature of the building may not admit of shutting out frost.

Millbury-St. School.—Heated by furnaces giving better ventilation than direct steam or stoves in the rooms, but the method is ill adapted to a building of this size, because of the difficulty of providing each

room with its proper quota of heated fresh air. One room is apt to get more than its proper share at the expense of some other room, and those conditions are apt to change places under different conditions of weather and wind.

The flues supplied for the escape of the vitiated air are warmed by the neighborhood of the smoke flues of the furnaces, but are inadequate in size and efficiency for the duty expected of them. It would perhaps be difficult to improve this detail without supplying special heaters for the exhaust flues, requiring a considerable outlay, and increased labor of attendance. But if the building is worthy of it, a good result would follow such a change.

The boys' urinal in the basement is provided with slate slabs in a proper manner, but the flushing water is applied too high and does not wet the whole surface of the slate as it ought to do. The same need of whitewash, light colored paint and frequent use of soap suds as in other houses.

The girls' side is especially dark and dingy, and should have more windows if possible.

The annex building in this school-yard is heated by indirect steam, supplemented by direct steam in cold places. A proper method. There are open fire-places in the school-rooms which are apparently the only means afforded for carrying off the vitiated air. If these flues were heated they might do this successfully, but they are only partial in their action. Alongside them is a large flue apparently enclosing a steam heating pipe, but, for some reason not visible, there is no draft into it at the openings. If this flue is closed or obstructed at its top, this trouble can be remedied by opening it.

In the basements are some hopper closets with filthy iron bases as complained of elsewhere, having traps below the floor while they should be above. Moreover there is an automatic attachment for applying the flushing water by the weight of the person on the seat, which like others of its class, is out of order and leads to the accumulation of filth.

The boys' urinal is not properly washed and smells badly.

Woodland-St. School.—Heated by furnaces and stoves, and therefore inadequately ventilated, especially where the latter are used (see comments above on heating by stoves and furnaces.)

On the second floor the outlets for vitiated air are near the ceiling, and therefore, if they act at all, they carry off the fresh air as fast as it comes in from the furnaces. They may serve a good purpose in summer, but in winter should be at or near the floor.

The floor of basement is a brick pavement too rough and absorbent to be cleanly about water-closets and urinals. It could be covered with Portland cement probably at a moderate cost, but should first be grouted with cement to hold the bricks in place. American cement is good enough for this and for levelling up the hollows in floor, preparatory to skimming with the more costly kind.

The boys' urinal is of slate, but the sprinkling tube is too high and does not wet the whole slate, white-wash and scrubbing brushes would be useful here as in other places noted above.

This building has an annex with four rooms heated by furnaces, which answer a better purpose here than in larger buildings. The heat from the furnace smoke-flues is used to accelerate the draft in contiguous flues that are used for removing the vitiated air from the rooms. But this agent is not sufficiently powerful for the duty required. Nothing short of a separate fire is adequate in such cases, where no steam pipes are to be had. It is doubtful whether there are any flues now existing in the chimnies where a separate fire could be used for this purpose, or whether new flues could be constructed at a reasonable cost.

I found the teachers' water-closets without a proper and efficient water supply, being a hopper with iron base, impossible to be kept clean, and poorly supplied with water, no special tank being provided. The soil pipe from these closets does not extend through the roof, as far as I can learn, and if it does not do so it should be so extended.

I found in the basement a pavement skimmed with Portland cement, and though not applied in the best manner, it will serve to illustrate the superior quality of this material when compared to coal-tar concrete, or American hydraulic cement.

The girls' water-closet is a trough sink, but does not extend the whole length as it should. It is supplemented by a single closet of poor construction, a dirty iron receptacle which it is not possible to keep clean. It should be removed. If the trough is not long enough to meet the reasonable wants of the pupils, a longer one can be put in its place, or a proper closet provided in place of the defective one of such a model as has been recommended above.

Respectfully submitted.

EDW. S. PHILBRICK.

